

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE BEFORE THE  
BOARD OF PATENT APPEALS AND INTERFERENCES**

In re Application of:	)	
M. Barrera et al.	)	
	)	
Serial No:     09/675,860	)	Group Art Unit: 3752
	)	
Filed:         September 29, 2000	)	Examiner: Christopher S. Kim
	)	
For:           APPARATUS AND METHOD OF	)	Date: August 6, 2007
EFFECTIVE FLUID INJECTION	)	
AND VAPORIZATION FOR	)	
CHEMICAL VAPOR DEPOSITION)	)	
APPLICATION	)	
	)	

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**BRIEF FOR APPELLANTS**

This is an appeal from the Final Rejection of the Examiner mailed March 8, 2007 finally rejecting claims 1-5, 7-10, 12-17, 19-21 and 26-31. A Notice Of Appeal and associated fee were timely mailed and received in the United States Patent and Trademark Office on June 8, 2007. An appeal brief fee in the amount of \$500 is submitted herewith. Please charge any over or under payment to Deposit Account No. 04-0566.

**REAL PARTY IN INTEREST**

The real party in interest is the assignee of all rights in this application, Novellus Systems, Inc., a corporation of the State of California, having a place of business at 3970 North First Street, San Jose, California 95134.

## **RELATED APPEALS AND INTERFERENCES**

There are no appeals or interferences known to Appellants, Appellants' legal representatives, or assignee, which will directly affect, or be affected by, or have a bearing on the Board's decision on this appeal.

## **STATUS OF CLAIMS**

The subject application was filed on September 29, 2000 with claims 1-23. In response to the Office Action mailed February 1, 2002, a Request for Restriction Requirement was mailed March 1, 2002, electing with traverse, the claims of Group I, claims 1-21, drawn to an apparatus.

An Office Action was mailed April 18, 2002, and a response thereto was filed June 5, 2002 wherein non-elected claims 22 and 23 were canceled, and claims 1-14 and 16-21 were amended. Figure 2 was also amended and Fig. 6 added. A Final Office Action was mailed August 12, 2002 rejecting the pending claims, to wit, claims 1-21. An Amendment After Final Rejection was submitted on October 22, 2002 amending the claims and adding new claims 24-27. An Advisory Action dated October 31, 2002 was received wherein it was advised that the Amendment filed October 22, 2002 would not be entered.

A Request for Continued Examination was filed November 7, 2002, along with a Replacement Amendment After Final Rejection in which amendments were made to claims 1, 2, 4-10, 12-14 and 16-21. A non-final Office Action was mailed January 1, 2003, still rejecting all the claims in the application, to wit, claims 1-21 and 24-27. In response, an Amendment was filed May 6, 2003 canceling claims 6, 11, 18, 24 and 25; amending claims 1, 2, 4, 5, 7, 8, 10, 13, 16, 17, 19, 21, 26, and 27; and adding claims 28-30. Fig. 2 was also amended.

A Final Rejection Office Action was mailed June 25, 2003 maintaining the rejection of the claims, to which a Response was filed August 7, 2003 where argument was presented but no amendments were made. A Notice of Appeal was filed September 23, 2003. Appellants' Brief was filed on November 12, 2003 appealing the rejection of claims 1-5, 7-10, 12-17, 19-21 and 26-30. The Examiner's Answer was filed on January 23, 2004. Appellants' corresponding Reply Brief was filed on March 24, 2004. The Board's Decision On Appeal was mailed November 18, 2005.

The Board found, in pertinent part, that it was not apparent from the wording of the claims "whether the chemical vapor deposition fluid delivery apparatus is claimed or whether a combination of such delivery apparatus and a chemical vapor deposition chamber is claimed." Board's Decision On Appeal, November 18, 2005, pp.7-8. Thus, the Board concluded that the claims did not satisfy the definiteness requirement of 35 U.S.C. § 112, second paragraph.

Having given a new ground of rejection pursuant to 37 C.F.R. § 41.50(b), the Board gave Appellants one of two possible options to avoid termination of the appeal: a) reopen prosecution; or b) request a rehearing. Appellants chose to reopen prosecution.

On January 13, 2006, Appellants submitted an amendment responsive to the Board's Decision On Appeal. Appellants modified the claims to specifically identify a combination of the delivery apparatus and a chemical vapor deposition chamber. Appellants supported these claim amendments with numerous examples from the specification. The Examiner did not challenge the adequacy of the Appellants' specification support for the proposed amendments. Instead, on May 23, 2006, the Examiner entered the Appellants' amendments and submitted a Final Office Action rejecting all claims under 35 U.S.C. § 103(a) as being unpatentable over the prior art of Gwyn (U.S. Patent No. 4,397,422) in view of Farnan (U.S. Patent No. 5,456,023).

On July 20, 2006, Appellants filed an amendment addressing the May 23, 2006 Final Office Action. The Examiner entered an Advisory Action on August 11, 2006, which did not enter the Appellants' July 20, 2006 amendments. Appellants submitted a Request For Continued Examination on August 23, 2006. The Examiner then entered Appellants' July 20, 2006 amendment, and followed with a Final Office Action on September 19, 2006, rejecting all claims under 35 U.S.C. § 103(a) as being unpatentable over Gwyn in view of Holt (U.S. Patent No. 5,501,397), apparently finding Appellants' arguments over Gwyn in view of Farnan persuasive. Appellants responded with an Amendment on December 19, 2006 addressing the Examiner's rejections, and adding new claim 31.

The Examiner entered the December 19, 2006 amendment, and submitted a Final Office Action on March 8, 2007. Appellants submitted an Amendment After Final on May 8, 2007 addressing the Examiner's Final Office Action. This amendment was not entered.

#### **STATUS OF AMENDMENTS**

All the amendments added during prosecution of the application have been entered except the May 8, 2007 amendment, which was deemed to recite new limitations. The rejected claims 1-5, 7-10, 12-17, 19-21 and 26-31, as they presently stand, are set forth in the Appendix. A summary of the rejection of the claims may be found in the Office Action mailed March 8, 2007.

#### **SUMMARY OF THE CLAIMED SUBJECT MATTER**

In chemical vapor deposition (CVD), reactants and other dopants are injected in vapor phase over substrates for deposition thereon. However, several problems are created by the physical properties that such materials undergo within the CVD chamber. (Specification, page 1, lines 9-15.)

Referring to Fig. 1, prior art has focused on pre-mixing solutions within a heated injector manifold 30 and transporting such pre-mixed fluids to a mixing chamber 35. (Specification, page 7, lines 3-18.) Once mixed, the mixture enters showerhead 26 through a ceramic tube 25, and then the solution vaporizes over a substrate for efficient mixing and deposition thereon. (Specification, page 7, lines 18-21; and page 3, lines 2-6.) However, certain precursors and dopants are not fully vaporized by such methods, such as tetraethylorthosilicate (TEOS), which does not fully atomize upon entering the gas manifold. This incomplete atomized of liquids entering into the gas manifold leads to inefficient deposition on the process wafers with the potential risk of carrier gas material landing on the wafer. (Specification, page 2, line 28 to page 3, line 25.)

The present invention is aimed at overcoming the above problems of pre-mixing, and then mixing, followed by the transportation of such mixed solutions to a chamber for injection therein. In so doing, the invention presents a delivery apparatus in combination with a chemical vapor deposition chamber for a semiconductor wafer fabrication process that avoids the stage of pre-mixing of solutions prior to introduction into mixing chamber 35 for the completion of mixing.

In particular, the present invention avoids pre-mixing of solutions by providing a chemical vapor deposition chamber in combination with a delivery apparatus, particularly a cross-flow injector, which includes an inlet nozzle, a throat region and an exit nozzle. (Specification, page 8, line 13 to page 9, line 8.)

The combination of a chemical vapor deposition chamber and the cross-flow injector is amply supported by the specification. First, the problem that the invention intends to address has been described as one of processing and fluid delivery within a chemical vapor deposition chamber:

The introduction of deposition reactants and other dopants has posed technical problems in the art that are governed, in part, by the physical properties these materials undergo *within the chemical vapor deposition process*. Some resolutions to these problems have incorporated direct injection of liquid solutions to introduce a deposition reactant *into a CVD deposition chamber*. (Specification, p.1, ll.12-17 (emphasis added)); and

The present methods in the art used to inject a carrier fluid (gas) such as tetraethylorthosilicate (TEOS) along with precursors and dopants into the gas manifold *leading to the reactor chamber* is inefficient and does not fully vaporize the injected fluids, especially the TEOS. (Specification, p.2, ll.16-19 (emphasis added))

Second, the invention is fully and completely described as it relates specifically to an application for chemical vapor deposition for semiconductor substrates, for example, identifying the predominant carrier fluid (gas) tetraethylorthosilicate (TEOS), which is used for such applications.

This invention is predominately used in a TEOS application, but may be valid for any liquid precursor and dopant liquids being injected into a process chamber. (Specification, p.13, ll.9-11.)

In more detail, the cross-flow injector of the present invention includes an inlet nozzle 50 for a carrier fluid, such as  $O_2$ ,  $N_2$ , or He, having a first diameter  $D_1$ , and configured to maintain a first pressure,  $P_1$ , and first temperature  $T_1$ . (Specification, page 8, lines 15-19.) The inlet nozzle 50 tapers to a narrower throat region 44, operating at mach 1.0, that has a second diameter  $D_2$  (smaller than  $D_1$ ), where the fluid undergoes a second pressure,  $P_2$  (lower than  $P_1$  and higher than a third pressure  $P_3$  at exit nozzle 42), and temperature,  $T_2$ . (Specification, page 8, lines 19-25.) Inlet ports 46 and 48 are connected to throat region 44 for injecting liquids 1 and 2 therein, whereby at the point of introduction into throat 44 are atomized by the fluid flow of the carrier fluid through the inlet nozzle 50 such that mixing occurs in the throat and at the exit nozzle 42. (Specification, page 8, line 25 to page 9, line 4.)

Further, several injection points may be introduced into the throat region 44 (such as inlets 46 and 48 for liquids 1 and 2) so that more than one liquid may be injected simultaneously, thus allowing for the doping of films while not requiring a pre-mixing of these liquids. (Specification, page 9, lines 5-8.) That is, no pre-mixing of liquids 1 and 2 occurs prior to their introduction into throat region 44 in the present apparatus.

As shown in Figs. 2 and 3A, the exit nozzle 42 may have a diameter  $D_3$  that is greater than the diameter  $D_2$  of the throat region 44 (Specification, page 9, lines 11-17), or alternatively as shown in Fig. 6, have substantially the same diameter as that of the throat 44,  $D_2$ , (Specification, page 10, lines 27-29). Regardless, an important feature of the invention is that more than one fluid may be introduced simultaneously into a chemical vapor deposition chamber through the cross-flow injector without pre-mixing the fluids. This provides for the fluid to be introduced into the low pressure process chamber and become efficiently atomized without concern of cavitation in the fluid supply lines. (Specification, page 14, lines 14-21.)

#### **GROUND OF REJECTION TO BE REVIEWED ON APPEAL**

I. Claims 1, 3-5, 7-10, 13, 15-17, 19-21, and 26-31 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over Gwyn (U.S. Patent No. 4,397,422) in view of Holt (U.S. Patent No. 5,501,397).

II. Claim 31 has been rejected under 35 U.S.C. § 112, first paragraph, as failing to comply with the written description requirement.

## ARGUMENT

### I. Prior Art

Gwyn (U.S. Patent No. 4,397,422) is directed to a paint sprayer. Specifically, Gwyn is directed to a colorant mixing and spraying device (10) that includes a pressurized air source (12) to supply relatively constant pressure air to a venturi mixer system (18) whereby colorants are drawn into the venturi throat for thorough mixing and subsequent introduction to a spray nozzle. (Fig. 1, and col. 1, lines 21-35 and col. 2, lines 20-22.)

The venturi mixer (18) has an inlet chamber (17), a throat (19) and an outlet chamber (21). Three tubes (20) leading from separate containers (22) of colorant are connected to the throat region (19), whereby colorant is suctioned into the throat region from the different containers (22) by the flow rate of air flowing from the inlet chamber (17) into the throat region (19). The colorants are mixed together in the venturi throat (19). The mixed colorant then flows from the outlet chamber (21) through a hose (26) to a spray gun (28) at a pressure high enough to vaporize the paint. (Gwyn, Fig. 1 and col. 2, lines 18-49.)

Appellants submit that Gwyn is limited to an apparatus (10) for mixing and spraying different colorants, i.e., paints, dyes and stains, to achieve various color combinations on a target workpiece, particularly, for the application of camouflage paints on military vehicles. (Gwyn, col. 1, lines 13-20 and col. 2, lines 18-20.) Gwyn does not disclose or teach an apparatus in combination with a CVD chamber for delivering CVD fluids. Nor does Gwyn teach a cross-flow injector in combination with a CVD chamber, whereby the cavity includes inlet and exit nozzles with a throat region there between as recited in independent claims 1, 13, 28 and 31.

Holt (U.S. Patent No. 5,501,397) is directed to a paint sprayer as well. Specifically, Holt teaches a recirculating paint supply system to supply single or multiple paint coatings to paint spray stations arranged in parallel or series. Importantly, Holt teaches the recirculation



of paint of a specific color to multiple stations. (Holt, col. 5, ll.1-13.) Holt further teaches an individual spray booth having a recirculating conduit to direct the liquid paint coating composition from the supply system to the spray gun. (Holt, col. 5, ll.14-19; Fig. 5.) Importantly, Holt's spray booth cannot be utilized for semiconductor processing.

## **II. The Examiner's Rejections and Appellants' Arguments**

### **A. 35 U.S.C. § 103(a) Rejections**

The Examiner has rejected claims 1, 3-5, 7-10, 13, 15-17, 19-21, and 26-31 under 35 U.S.C. 103(a) as being unpatentable over Gwyn in view of Holt.

The Examiner states that Gwyn discloses all of the recited elements of the delivery apparatus. The Examiner further states that Holt discloses a chamber having a spray gun attached to the spray booth and in communication with the chamber. (March 8, 2007 Office Action, p.3.) The Examiner contends that it would have been obvious to a person having ordinary skill in the art to have provided a chamber to the device of Gwyn as taught by Holt to reduce dust contamination. (*Id.*) The Examiner further remarks that the paint sprayed, as in the spray booth of Holt, is a chemical in vapor fluid form and is deposited on the painted surface, and has determined that the Holt chamber literally meets the definition of "chemical vapor deposition chamber." (*Id.* at 4).

As recited, independent claims 1, 13, 28 and 31 are directed to the combination of a chemical vapor deposition chamber for processing a semiconductor substrate and an apparatus for delivering a plurality of chemical vapor deposition fluids to the chamber. The chemical vapor deposition chamber works in combination with the delivery apparatus to deliver a plurality of chemical vapor deposition fluids to a semiconductor substrate. The delivery apparatus is attached to, and in fluid communication with, the chemical vapor deposition chamber, and includes a cavity comprising an inlet nozzle, a throat region and an exit nozzle.

Appellants respectfully submit that Gwyn is merely directed to a non-analogous paint-spraying device for mixing and spraying different colorants utilizing a venturi mixer system.

Appellants disagree with the Examiner's statement that the specification fails to limit the definition of the term "chemical vapor deposition" and Gwen "is analogous art in that the deposition of paint meets the literal definition of 'chemical vapor deposition'." September 19, 2006 Office Action, p.4.

Appellants respectfully submit that the specification is replete with direct application to chemical vapor deposition *for the semiconductor arts*, including the injection of TEOS, which would not be found in paint spraying applications.

In a chemical vapor deposition (CVD) process, species in the vapor phase are injected over a substrate (or wafer) and react to form a deposit on the substrate. *Often, this is done with plasma enhancement (PECVD).* This technique provides for superior coverage of complex topographies on the substrate surface. (Specification, p.1, ll.9-12) (emphasis added).

The cross-flow injector operating under the conditions set forth in Table 1 above for helium would allow the introduction of TEOS and other dopant fluids at a relatively high pressure (29.2 psia), and would not require the use of capillary tubes to create a pressure differential. The choked, narrowed throat provides this needed pressure differential. Helium is used mainly to offset the auto-ignition concerns with TEOS. (Specification, p.13, l.30 – p.14, l.4.)

Two criteria have evolved for determining whether prior art is analogous: (1) whether the art is from the same field of endeavor, regardless of the problem addressed, and (2) if the reference is not within the field of the inventor's endeavor, whether the reference still is reasonably pertinent to the particular problem with which the inventor is involved. In re Clay, 23 USPQ2d 1058, 1060 (Fed. Cir. 1992) (citing, In re Deminski, 796 F.2d 436, 442, 230 USPQ 313, 315 (Fed. Cir. 1986); In re Wood, 599 F.2d 1032, 1036, 202 USPQ 171, 174 (CCPA 1979)).

Appellants submit that the cited art for spray painting automobiles, as taught in Gwyn and Holt, is not within the same field of endeavor as the semiconductor arts. Moreover, Appellants respectfully submit that the Examiner's characterization of the problem solved by the instant invention is broader than the particular problem with which Appellants attempted to overcome. Appellants endeavor to inject a carrier fluid (gas) such as tetraethylorthosilicate (TEOS) along with precursors and dopants into the gas manifold leading to a CVD reactor chamber for semiconductor processing. (Specification, p.2, ll.16-19.) This endeavor places the problem that Appellants are attempting to solve out of the field of automobile spray guns and tents.

Precise definition of the problem is important in determining whether a reference is from a non-analogous art. Defining the problem too narrowly may result in excluding consideration of relevant prior art. By the same token, defining the problem too broadly, as done here, may result in considering prior art as "analogous" which is inconsistent with real world considerations. Ex parte Dussaud, 7 USPQ2d 1818, 1819 (BPAI 1988); see also Panduit Corp. v. Dennison Mfg. Co., 774 F.2d 1082, 227 USPQ 337 (Fed. Cir. 1985), vacated, 475 U.S. 809, 229 USPQ 478 (1986), aff'd on remand, 810 F.2d 1561, 1 USPQ2d 1593 (Fed. Cir. 1987).

Furthermore, Appellants respectfully submit that the meaning of the term dopant as intended, i.e., for the deposition of reactants and other dopants within a chemical vapor deposition chamber, is within the common meaning of the term. One of ordinary skill in the semiconductor arts would not interpret the term dopant to include dyes or paints, as neither are reactants that alter the properties of a pure substance. Inherent in the application of a chemical vapor deposition chamber is the understanding that the mixed dopants create an atmosphere within the entire chamber for application of the depositing material. A person of ordinary skill in the art would not use a paint spray gun to create an atmosphere of dopant

material within an entire chamber. By its application, the paint spray gun of Gwyn is uniquely a directional device, which is not desirable for application in a chemical vapor deposition chamber, where the entire atmosphere is purposely altered and affected, and specific directionality is not intended.

Appellants further note, *arguendo*, that even if the cited art of Gwyn and Holt were considered analogous, the combination would be inappropriate for an obviousness-type rejection. Holt teaches a recirculating paint supply system with a substantially flexible recirculating fluid conduit connected at one end to a spray gun and the other end to supply and return lines. (Holt, col. 2, ll.49-54.) Semiconductor processing does not lend itself to recirculating gases, since this would initiate unwanted contamination.

Appellants respectfully disagree with the Examiner use of the Holt design as an analogous disclosure of a chemical vapor deposition chamber for use in combination with the Gwyn spray gun. First, paint spray booths are not semiconductor processing chambers. Second, it would certainly not be appropriate to combine the paint spray gun of Gwyn with a chemical vapor deposition chamber used to treat semiconductors as claimed in the instant invention, nor has the Examiner attempted to do so. This combination would not be logical. Instead, the Examiner has combined an automobile paint spray gun with an automobile paint spray booth.

The paint spray booth of Holt cannot work as a chemical vapor deposition chamber for receiving an atmosphere of mixed dopants that would allow for the simultaneous and uniform deposition of a material on a substrate. "The walls of the spray booth are formed from rectangularly shaped pads of removable plastic so that walls may be cleaned by simply removing the layers of film." (Holt, col. 7, ll.22-24.) Dopants and carrier gases used in the semiconductor arts (such as TEOS) would dissolve the plastic walls of the Holt booth. Moreover, the Holt booth is not a chamber in the sense of how a chamber is used in the

administration of dopants for the semiconductor arts. Specifically, a vacuum cannot be applied therein, nor can high temperatures or positive pressure be sustained. "As shown, a product to be painted such as an automotive vehicle 90, is moved through the spray booth by a conveyor system 92." (Holt, col. 7, ll.21-22.) The Holt booths are open-air enclosures, not high temperature, vacuum chambers.

Appellants further note that the present invention includes other salient, claimed features that make it patentably distinct over the combination of Gwyn and Holt.

In the present invention the apparatus includes a throat region that has a first aperture adjacent its first end for injecting a first CVD dopant and a second aperture adjacent its second end for injecting a second CVD dopant in the throat region. (See, e.g., Claim 1.) This allows for atomization of the first and second CVD dopants by the carrier fluid and mixing of the atomized CVD dopants with the carrier fluid within the throat region. The exit nozzle, connects to the throat region at the second end, has an exit pressure lower than the second pressure. (Id.) The exit nozzle is configured to introduce the mixture of atomized first and second CVD dopants with the carrier fluid within the CVD chamber. In so doing, this exit nozzle may have a third diameter greater than the second diameter to allow for a substantial decrease in pressure from the first pressure to the exit pressure, or alternatively, it may have the same dimension as the throat region. That is, the exit nozzle may have a constant dimension that is equal to the dimension of the throat region, such that the exit nozzle is an extension of the throat region thereby maintaining the second pressure and temperature for the atomized CVD dopants/precursors and the carrier fluid for introduction of the same into the CVD chamber. (See, e.g., Claim 13.) Importantly, Gwyn does not teach, disclose, or suggest these claimed features, and neither does the combination of Gwyn with the so-called "chemical vapor deposition chamber" of Holt.

Since the Examiner relies solely on Gwyn to reject features of the delivery apparatus, it is important to note that Gwyn does not disclose differing temperatures within the inlet chamber, throat region and outlet chamber, nor does Gwyn disclose an exit nozzle configured to introduce atomized chemical vapor deposition fluid and carrier fluid in a CVD chamber. (See, e.g., Claims 1, 4, 13, 16, 28, 29, 30 and 31.)

Furthermore, Claim 5 defines the first and second chemical vapor deposition dopants comprising TEOS. The Examiner states that "[i]n claim 1, the first and second chemical vapor deposition dopants are not positively recited. The dopants are merely recited as intended use of the first and second aperture of the throat region of the apparatus being claimed." (March 8, 2007 Office Action, p.4.) Appellants disagree.

Appellants have claimed the introduction of certain fluids, such as TEOS, because the present invention must operate within the destructive environment established by the induction of these substances. The automobile sprayers of the cited prior art could not survive this environment, and the chamber in the cited prior art of Holt cannot contain these substances.

Claims 5, 17 and 31 place a limitation on the structural combination of a chemical vapor deposition chamber and delivery apparatus that is not otherwise cited in claim 1, and certainly not disclosed or discussed in Gwyn and Holt, which is, the combination of the chemical vapor deposition chamber and delivery apparatus must survive in a TEOS environment. The Holt chamber is an open air, non-vacuum chamber, made for human activity. This cannot accommodate a TEOS environment.

Gwyn and Holt are completely silent regarding working with TEOS, or surviving the adverse TEOS environment that is normally associated with semiconductor processing. Appellants respectfully submit that having a cavity that can survive a semiconductor processing environ, i.e., a TEOS environment that does not allow the TEOS to exceed its

auto-ignition point, makes the present invention as claimed in claims 5, 17 and 31, patentably distinct over the cited prior art.

Furthermore, although the Examiner states that the Holt "chamber literally meets the definition of chemical vapor deposition chamber" (March 8, 2007 Office Action, p.4.), this is not accurate. The chamber of the present invention MUST BE a chemical vapor deposition chamber for processing semiconductor substrates. The phrase "for processing semiconductor substrates" is a structural limitation on the chamber. The Holt booth cannot meet this requirement as is presently understood by persons having ordinary skill in the art. As Appellants have stated previously, the paint spray booth of Holt would not work as a chemical vapor deposition chamber for receiving an atmosphere of mixed dopants that would allow for the simultaneous and uniform deposition of a material on a substrate. Holt's chamber is not, nor was it ever meant to be, TEOS resilient.

Appellants submit that the present invention is patentably distinct over the cited prior art of Gwyn in view of Holt, as all material elements of the claimed delivery apparatus are not, and cannot, be found in Gwyn patent, nor does Holt disclose a chemical vapor deposition chamber suitable for semiconductor processing as required by the cited claims. The combination of Gwyn and Holt does not make the present invention obvious.

To further distinguish claims 13, 15-17, 19-21, 27, 30 and 31 from Gwyn, these claims are directed to a chemical vapor deposition chamber having a cavity that includes an inlet nozzle, a throat region and an exit nozzle, whereby the exit nozzle has the same dimensions (diameter, pressure and temperature) as the throat region. In the Gwyn patent, as shown in Figs. 1 and 2, the outlet chamber (21) is larger than the throat region (19) such that the two do not have the same diameter, and therefore, do not have the same dimensions.

Accordingly, Appellants submit that claims 13, 15-17, 19-21, 27, 30 and 31 include limitations not disclosed nor contemplated by Gwyn such that Gwyn cannot render obvious these claims.

With respect to claims 2, 12 and 14, the Examiner states that it would have been obvious to one of ordinary skill in the art to alter the inlet and exit nozzle angles for optimization dependent of application criteria. In addition to the above distinctions, Appellants disagree as Gwyn does not disclose or suggest altering a nozzle angle such that the nozzle is configured to introduce atomized chemical vapor deposition dopants/precursors and a carrier fluid into a CVD chamber for semiconductor processing. Gwyn teaches a directional device for administering paints or dyes. The optimal criterion for the mixing and application of dopants for semiconductor processing has not been taught, disclosed, or suggested by Gwyn.

Claims 3 and 15 require the throat region to be configured to operate at a critical mach number of 1. The specification teaches the conditions for this configuration:

The initial pressure at the inlet,  $P_1$ , is related to the pressure at the throat,  $P_2$ , as follows:

$$P_1/P_2 = [1 + (1/2)(k-1)M_a^2]^{k/(k-1)} \quad (2)$$

where,

$M_a$  is the Mach number;

$P_1$  is the stagnant pressure; and,

$P_2$  is the throat pressure.

This equation is generally used to determine the gas velocity and gas properties within the expansion nozzle.

For a Mach number equal to 1, equation (2) may be simplified to the following:

$$P_2/P_1 = [2/(k+1)]^{k/(k-1)} \quad (3)$$

Specification, p.11, ll.17-28.

Gwyn in view of Holt does not teach or disclose any such configuration conditions. Consequently, this prior art cannot support a throat region configuration for a mach number equal to 1. The analytical conditions delineated within the specification for a mach number



equal to 1 must be satisfied. The specification teaches this, and claims 3 and 15 require this analytical satisfaction. Gwyn is silent regarding any teaching of this configuration.

**B. 35 U.S.C. § 112 Rejection**

The Examiner has rejected claim 31 under 35 U.S.C. § 112, first paragraph, as failing to comply with the written description requirement. Specifically, the Examiner contends that claim 31 recites, "... while not requiring the use of capillary tubes to create a pressure differential ... ," and that this negative limitation is not found in the written description. Appellants respectfully disagree. The specification reads in pertinent part:

The cross-flow injector operating under the conditions set forth in Table 1 above for helium would allow the introduction of TEOS and other dopant fluids at a relatively high pressure (29.2 psia), *and would not require the use of capillary tubes to create a pressure differential*. The choked, narrowed throat provides this needed pressure differential. Helium is used mainly to offset the auto-ignition concerns with TEOS. Specification, p.13, l.30 – p.14, l.4 (emphasis added).

The Examiner further rejects claim 31 under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the applicants regard as the invention. Specifically, the Examiner states it is uncertain whether the recitation of "... while not requiring the use of capillary tubes to create a pressure differential ... " requires the apparatus itself to create a pressure differential, the apparatus not to require a capillary tube, or the apparatus to have capillary tubes as long as they do not create a pressure differential.

Appellants respectfully submit that the claim language is clear in its meaning: "... introducing TEOS and other dopant fluids at a high pressure, while not requiring the use of capillary tubes to create a pressure differential ... ." This is supported by the specification as cited above, where "[t]he cross-flow injector ... would allow the introduction of TEOS and other dopant fluids at a relatively high pressure (29.2 psia), *and would not require the use of capillary tubes to create a pressure differential*." Moreover, as further stated in the

specification, "The choked, narrowed throat provides this needed pressure differential."  
(Specification, p.13, ll.5-6.) Appellants submit that the claimed negative limitation is clearly  
cited and supported by the specification. The apparatus does not require the use of capillary  
tubes to create a pressure differential because the narrow throat region provides this pressure  
differential.

### SUMMARY

It is respectfully submitted that the cited prior art of Gwyn in view of Holt does not  
disclose nor teach Appellants' invention. It is also submitted that the dependent claims further  
distinguish the present invention over the prior art for the reasons given above. Furthermore,  
claim 31 is adequately supported by the specification, and should not be rejected under 35  
U.S.C. § 112, first paragraph.

Accordingly, Appellants respectfully submit that the claimed invention, as a whole,  
is not obvious over the cited prior art and that claims 1-5, 7-10, 12-17, 19-21 and 26-31 are  
patentable over the references. The Final Rejection should be reversed and the claims should  
be allowed to issue.

Respectfully submitted,

A handwritten signature in dark ink, appearing to read "R. Curcio". The signature is written in a cursive, flowing style. Below the signature is a horizontal line.

Robert Curcio  
Reg. No. 44,638

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## APPENDIX

### Rejected Claims of Serial No. 09/675,860

The claims of the present application are as follows:

1. The combination of a chemical vapor deposition chamber and an apparatus for delivering a plurality of chemical vapor deposition fluids to said chamber, comprising:  
said chemical vapor deposition chamber for processing a semiconductor substrate;  
said apparatus for delivering said plurality of chemical vapor deposition fluids to said substrate, said apparatus attached to, and in fluid communication with, said chamber, and having a cavity comprising an inlet nozzle, a throat region and an exit nozzle,  
said inlet nozzle having a first diameter adapted to receive a carrier fluid, and having a first pressure and a first temperature;  
said throat region, having a first and second end, connected to said inlet nozzle at said first end, said throat region having a second diameter less than said first diameter and adapted to receive said carrier fluid from said inlet nozzle, said throat region having a second pressure lower than said first pressure and a second temperature, and having a first and a second aperture adjacent to said first and second ends for injecting, respectively, a first and a second chemical vapor deposition dopant into said throat region to allow for atomization of said first and second chemical vapor deposition dopants by said carrier fluid and mixing of said atomized first and second chemical vapor deposition dopants with said carrier fluid; and  
said exit nozzle, connected to said throat region at said second end, having an exit pressure lower than said second pressure and a third temperature, said exit nozzle having a third diameter greater than said second diameter to allow for a substantial decrease in pressure from said first pressure to said exit pressure, and configured to introduce said mixed atomized first and second chemical vapor deposition dopants and said carrier fluid in the chemical vapor deposition chamber.

2. The combination of claim 1 wherein said inlet nozzle having said first diameter is adapted to receive and funnel said carrier fluid to said throat region having said second diameter, said inlet nozzle narrowing at an angle in the range of forty to sixty degrees.
3. The combination of claim 1 wherein said throat region is configured to operate at a critical Mach number of 1.0.
4. The combination of claim 1 wherein said second pressure and said second temperature are selected to present a condition for atomization of said first and second chemical vapor deposition dopants.
5. The combination of claim 1 wherein said first and second chemical vapor deposition dopants comprise TEOS.
6. (Canceled.)
7. The combination of claim 1 wherein said throat region is configured to maintain said first pressure to be greater than said third pressure to enhance atomization of said first and second chemical vapor deposition dopants.
8. The combination of claim 1 wherein said throat region is adapted such that said second pressure is lower than said first pressure allowing for said first and second chemical vapor deposition dopants to be injected into said throat region.
9. The combination of claim 1 wherein said inlet nozzle is adapted to receive said carrier fluid at a constant flow rate ensuring said second pressure being maintained constant through said throat region.
10. The combination of claim 1 wherein said first and second chemical vapor deposition dopants are introduced simultaneously into said throat region without pre-mixing.
11. (Canceled.)

12. The combination of claim 1 wherein said exit nozzle expands to said third diameter from said throat region second diameter at an angle in the range of twenty to forty degrees.

13. The combination of a chemical vapor deposition chamber and an apparatus for delivering a plurality of chemical vapor deposition fluids to said chemical vapor deposition chamber, comprising:

said chemical vapor deposition chamber for processing a semiconductor substrate; and  
said apparatus for delivering said plurality of chemical vapor deposition fluids to said substrate, said apparatus attached to, and in fluid communication with, said chamber, and having a cavity comprising an inlet nozzle, a throat region and an exit nozzle,

said inlet nozzle having a first diameter adapted to receive a carrier fluid, and having a first pressure and a first temperature, said carrier fluid comprising a process compatible gas selected from the group consisting of O<sub>2</sub>, N<sub>2</sub>, and He;

said throat region, having a first and second end, connected to said inlet nozzle at said first end, said throat region having a second diameter less than said first diameter, and adapted to receive said carrier fluid from said inlet nozzle, said throat region having a second pressure and a second temperature and having a first and a second aperture adjacent to said first and second ends for injecting, respectively, a first and a second chemical vapor deposition fluid into said throat region to allow for atomization of said first and second chemical vapor deposition fluid by said carrier fluid and mixing of said atomized first and second chemical vapor deposition fluid with said carrier fluid, said first and second chemical vapor deposition fluids comprise fluids selected from the group consisting of precursors and dopants; and,

said exit nozzle, connected to said throat region at said second end, having said second diameter, said exit nozzle configured to maintain said second pressure and said second temperature, such that said exit nozzle is an extension of said throat region consisting of the same dimensions as said throat region, said exit region configured to introduce said atomized first and second chemical vapor deposition fluid and said carrier fluid in said chemical vapor deposition chamber.

14. The combination of claim 13 wherein said inlet nozzle having said first diameter is adapted to receive and funnel said carrier fluid to said throat region having said second diameter, said inlet nozzle narrowing at an angle in the range of forty to sixty degrees.

15. The combination of claim 13 wherein said throat region is configured to operate at a critical Mach number of 1.0.

16. The combination of claim 13 wherein said second pressure and said second temperature are selected to present a condition for atomization of said first and second chemical vapor deposition fluid.

17. The combination of claim 13 wherein said first and second chemical vapor deposition fluids comprise TEOS.

18. (Canceled.)

19. The combination of claim 13 wherein said throat region, having said second diameter, is adapted such that said second pressure is lower than said first pressure allowing for said first and second chemical vapor deposition fluid to be injected into said throat region.

20. The combination of claim 13 wherein said inlet nozzle is adapted to receive said carrier fluid at a constant flow rate ensuring said second pressure being maintained constant through said throat region.

21. The combination of claim 13 wherein said first and second chemical vapor deposition fluids are introduced simultaneously into said throat region without pre-mixing.

22.-25. (Canceled.)

26. The combination of claim 1 wherein said throat region further comprises a third aperture for injecting a third chemical vapor deposition dopant into said throat region to allow for atomization of said third chemical vapor deposition dopant by said carrier fluid, and allow for mixing of said atomized first, second and third chemical vapor deposition dopants with said carrier fluid.

27. The combination of claim 13 wherein said throat region further comprises a third aperture for injecting a third chemical vapor deposition fluid into said throat region to allow for atomization of said third chemical vapor deposition fluid by said carrier fluid, and allow for mixing of said atomized first, second and third chemical vapor deposition fluids with said carrier fluid.

28. The combination of a chemical vapor deposition chamber and an apparatus for delivering a plurality of chemical vapor deposition fluids to said chamber, comprising:

said chemical vapor deposition chamber for processing a semiconductor substrate; and  
said apparatus for delivering said plurality of chemical vapor deposition fluids to said substrate, said apparatus attached to, and in fluid communication with, said chamber, having a cavity comprising a cross-flow injector, said cross-flow injector comprising an inlet nozzle, a throat region and an exit nozzle;

said inlet nozzle having a first diameter adapted to receive a carrier fluid, and having a first pressure and a first temperature, said carrier fluid comprising a process compatible gas selected from the group consisting of O<sub>2</sub>, N<sub>2</sub>, and He;

said throat region, having a first and second end, connected to said inlet nozzle at said first end, said throat region having a second diameter less than said first diameter, and adapted to receive said carrier fluid from said inlet nozzle, said throat region having a second pressure and a second temperature and having a first and a second aperture adjacent to said first and second ends for injecting, respectively, a first and a second chemical vapor deposition dopants into said throat region to allow for atomization of said first and second chemical vapor deposition dopants by said carrier fluid and mixing of said atomized first and second chemical vapor deposition dopants with said carrier fluid; and,

said exit nozzle, having an exit pressure, connected to said throat region at said second end for receiving said atomized first and second chemical vapor deposition dopants and said carrier fluid; and

wherein said chemical vapor deposition chamber is adapted to receive said mixture of atomized first and second chemical vapor deposition dopants with said carrier fluid from said exit nozzle of said cavity.

29. The combination of claim 28 wherein said exit nozzle has an exit pressure lower than said second pressure and a third temperature, said exit nozzle having a third diameter greater than said second diameter to allow for a substantial decrease in pressure from said first pressure to said exit pressure, and configured to introduce said atomized first and second chemical vapor deposition dopants and said carrier fluid in the chemical vapor deposition chamber.

30. The combination of claim 28 wherein said exit nozzle has said second pressure and said second temperature, such that said exit nozzle is an extension of said throat region consisting of the same dimensions as said throat region, said exit region being configured to introduce said atomized first and second chemical vapor deposition dopants and said carrier fluid in said chemical vapor deposition chamber.

31. The combination of a chemical vapor deposition chamber and an apparatus for delivering a plurality of chemical vapor deposition fluids to said chamber, comprising:

said chemical vapor deposition chamber for processing semiconductor substrates;

said apparatus for introducing TEOS and other dopant fluids at a high pressure, while not requiring the use of capillary tubes to create a pressure differential, said apparatus attached to, and in fluid communication with, said chamber, and having a cavity comprising an inlet nozzle, a throat region and an exit nozzle,

said inlet nozzle having a first diameter adapted to receive a carrier fluid, and having a first pressure and a first temperature;

said throat region, having a first and second end, connected to said inlet nozzle at said first end, said throat region having a second diameter less than said first diameter and adapted to receive said carrier fluid from said inlet nozzle, said throat region having a second pressure lower than said first pressure and a second temperature, and having a first and a second aperture adjacent to said first and second ends for injecting, respectively, a first and a second chemical vapor deposition dopant into said throat region to allow for atomization of said first and second chemical vapor deposition dopants by said carrier fluid and mixing of said atomized first and second chemical vapor deposition dopants with said carrier fluid; and

said exit nozzle, connected to said throat region at said second end, having an exit pressure lower than said second pressure and a third temperature, said exit nozzle



having a third diameter greater than said second diameter to allow for a substantial decrease in pressure from said first pressure to said exit pressure, and configured to introduce said mixed atomized first and second chemical vapor deposition dopants and said carrier fluid in the chemical vapor deposition chamber.